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GB 2330157 A GB 2280460 A

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(54) Abstract Title
Concentric catenary riser

(57) A catenary riser is formed from a central pipe 1 for the flow of oil or gas and an outer pipe 3. The annular space 4 may contain a service line 2 and be filled with, water, thermal insulation materials, gas for gas lift or injection purposes, a chemical for chemical injection, air or a vacuum.

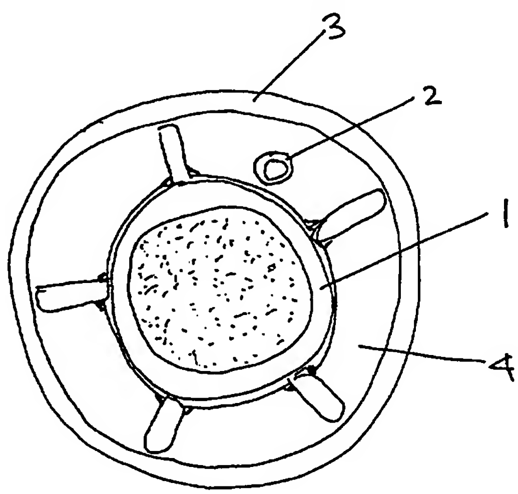

FIGURE 2

GB 2 351 301 A

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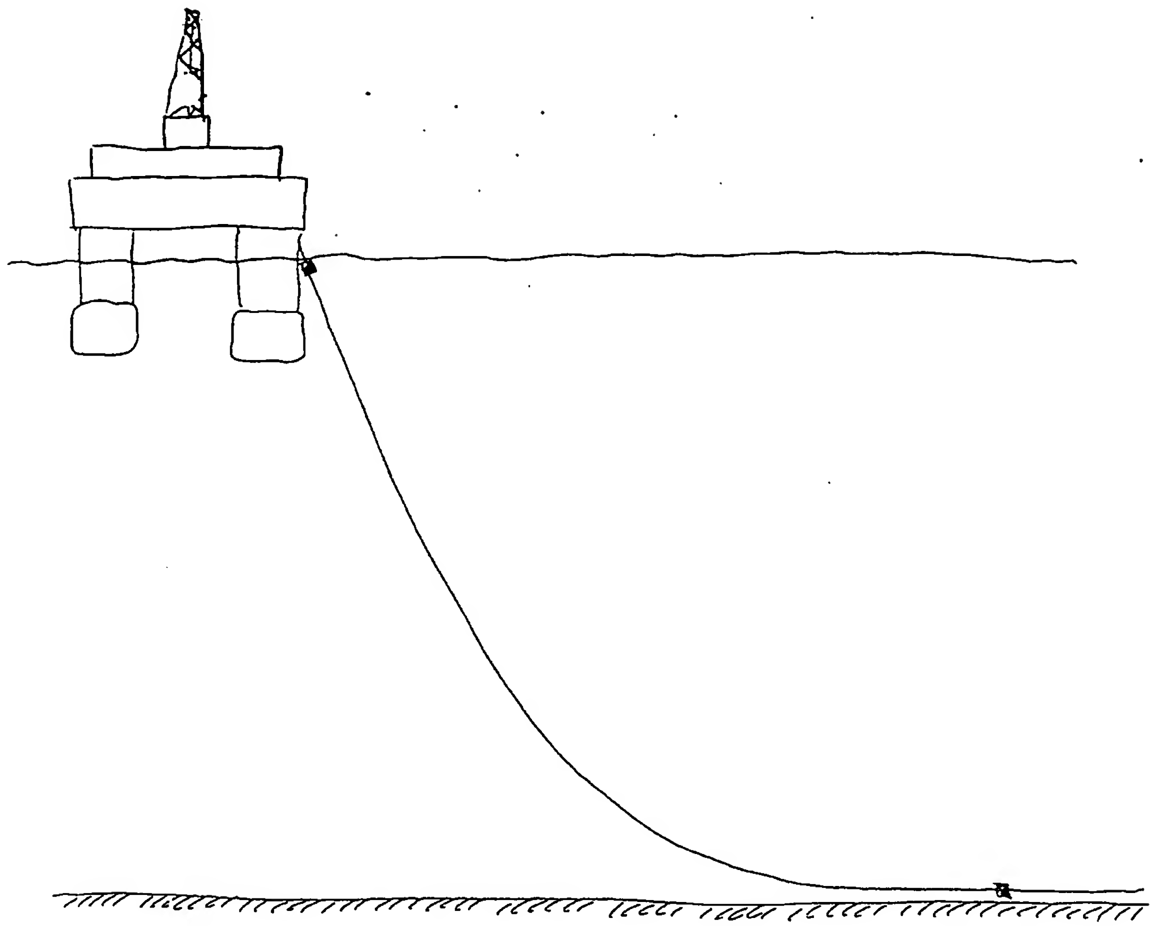

FIGURE 1

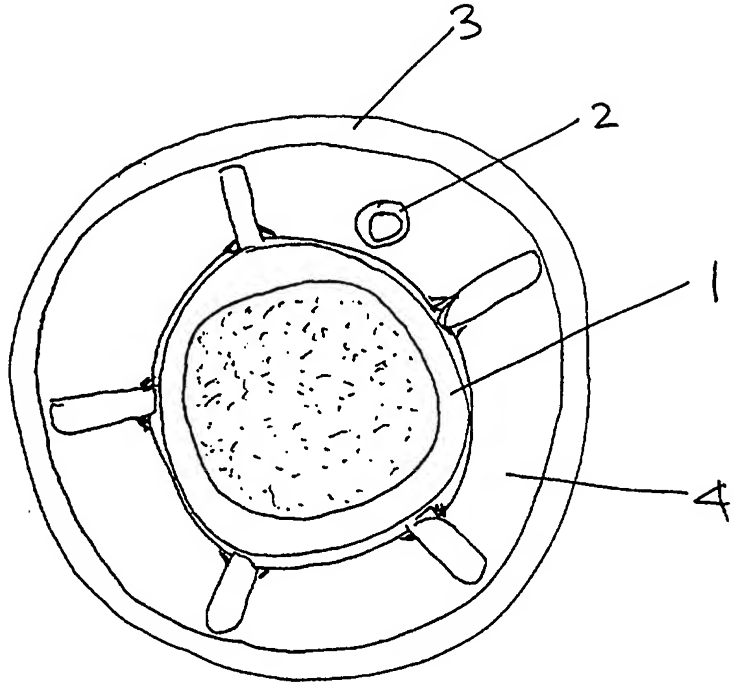

FIGURE 2

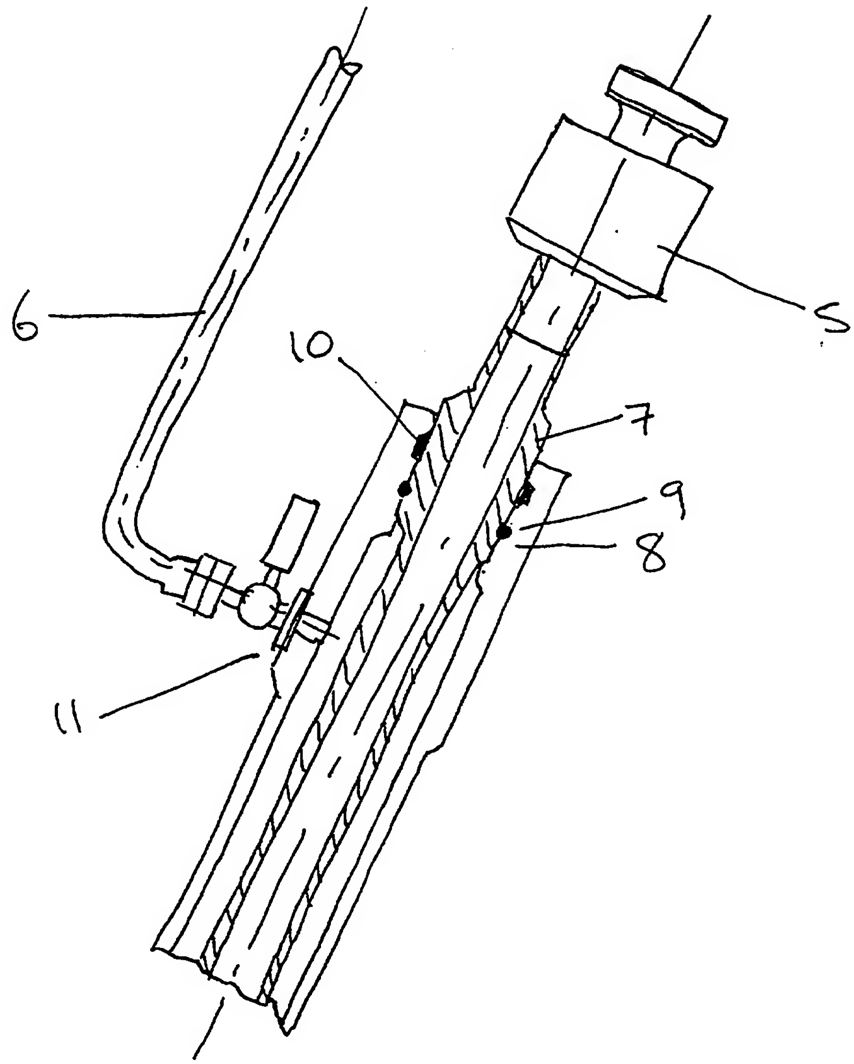

FIGURE 3

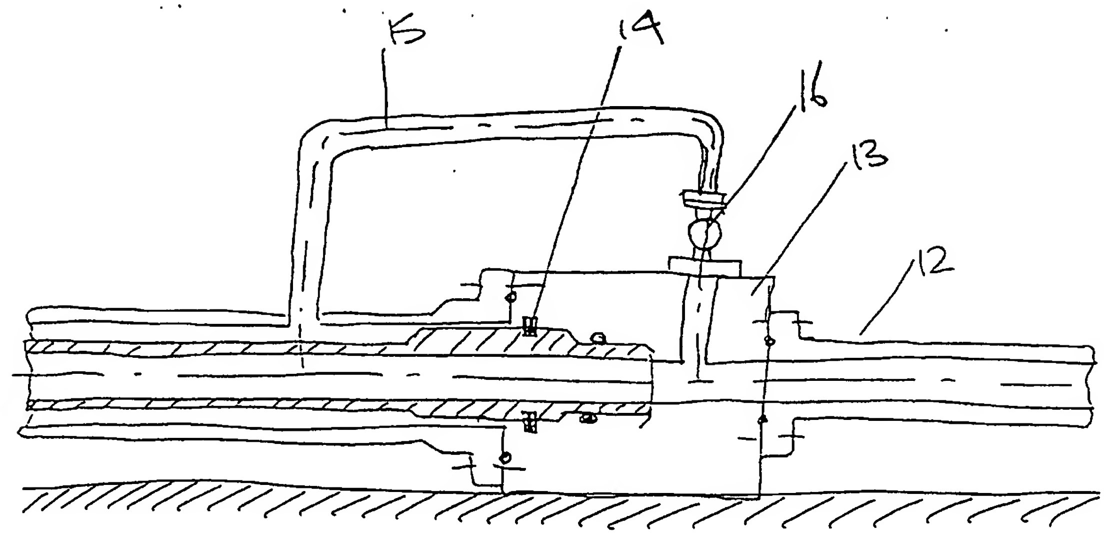

FIGURE 4

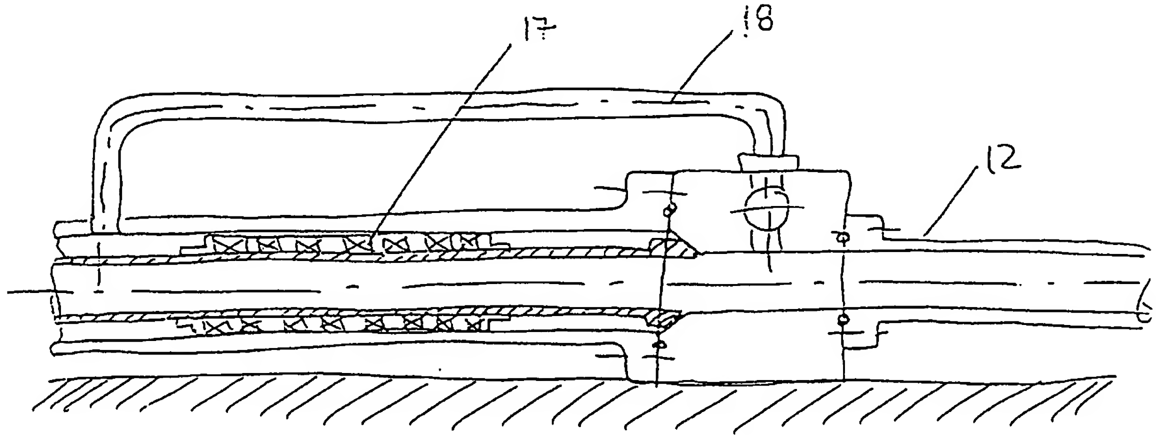

FIGURE 5

BRITISH PATENT APLICATION
CONCENTRIC CATENARY RISER (CCR)

This invention concerns a steel catenary riser system used in the recovery of offshore oil and gas reserves in deep water environments. The presented system offers the means to provide effective thermal insulation, riser base gas lift, active production fluid heating, chemical injection, fatigue resistant hardware and straightforward installation using conventional pipeline and riser installation techniques.

Background to the Invention

As oil exploration and production moves into deeper water there is a need to develop both technically viable and cost effective riser systems. Risers may take many forms but typically consist of a single or a bundle of pipes that extend vertically or in a catenary from the seabed and connect to the vessel or terminate near the vessel. As water depths increase there is increasing need for riser systems with high levels of thermal insulation to maintain arrival temperatures and to prevent hydrates and wax deposition during shutdown periods.

Summary of Invention

The present invention proposes a catenary riser configuration, Figure 1, which may be installed either by tow out following onshore assembly or by offshore assembly using a pipe lay vessel or drilling rig. The riser cross section consists of a single primary flow path, which takes the form of a concentric bundle arrangement of a pipe in pipe. In addition one or more smaller diameter service or control lines may also be included on the outside or within the annulus of the pipe in pipe system. A typical arrangement is shown in Figure 2 in which a central flow path 1 and a service line 2 are located inside an outer pipe 3. The annular space 4 may be filled with water, thermal insulation materials, gas such as methane for gas lift or injection purposes, chemical injection such as glycol, air or be vacuumed.

Different fluids may be used in the annulus depending on the riser operating mode. Gas lift can be performed down the annulus and provides a convenient way of also heating the central flow path. As the gas is hot, following compression, the riser acts like a long heat exchanger transferring heat from the gas into the production fluid. Air filling or evacuating the annulus to a near vacuum provides an economical means of thermal insulation and may be considered during shut down periods. In addition thermal insulation and buoyancy materials may also be used in the annular space and/or attached to the outside of the outer pipe.

The annulus may also be water flooded. This increases the riser weight, which can significantly improve the response particularly at the point where the riser touches the seabed. For this reason, it is possible that such an arrangement can accommodate higher vessel motions and more severe environmental loading than when gas filled. For this reason it is proposed that the riser is water flooded at times of extreme storm. After the storm has passed the water is purged out of the annulus using an air drive. A further benefit of the concentric bundle arrangement is that it provides a second pressure barrier, enhancing the reliability and ability to detect leaks or failure of the inner pipe

As the configuration has a single main flow path, it is anticipated that a number of such CCRs will be required to accommodate the development requirements of a large deepwater field.

Description of Invention

In the present invention the riser is configured in a simple catenary. It is attached to the vessel via a flex joint and extends down to the seabed where it is connected to a subsea flowline. The riser cross section consists of a central pipe, located within a larger diameter external pipe and with a small chemical injection or control line pipe located in the annulus. The smaller service lines in the annulus are wrapped around the central pipe in a helical fashion so as to accommodate thermal and pressure end cap effects. The outside surface of the outer pipe is coated with a corrosion protection material such as fusion-bonded epoxy or thermally sprayed aluminium.

The central pipe diameter is sized for the main flow path. The annulus between the central and outer pipe is filled with air, which together with a coating if necessary on the outer pipe provides the desired thermal insulation to the production pipe.

The steel pipes are formed from high strength seamless pipe and may be either welded or connected using mechanical connections. The wall thickness of the pipes is determined using relevant codes and standards, with subsequent analysis undertaken to optimise the riser configuration under dynamic loading. The size and wall thickness of each pipe varies from riser to riser depending on water depth, reservoir flow characteristics and production requirements.

At the vessel the riser is terminated with a flex joint 5, swivel or other compliant device that allows relative angular motion between the riser and vessel. The flex joint has a single flow path for the central production line. The annulus 6 and the smaller lines are ported around the flex joint using a flexible jumper or other compliant pipe work as shown in Figure 3.

The upper end of the central pipe is terminated in thickened section or hanger 7, which locates in a bowl 8 welded to the top end of the outer pipe. The interface between the hanger and bowl is sealed using a replaceable seal assembly 9. The weight of the outer pipe is supported off the hanger via the bowl using a load shoulder and series of dogs 10. A side port 11with a studded flange face is provided in the bowl allowing access into the annulus. The port is isolated by valve, which is connected by flexible piping to the vessel termination.

On the seabed the riser connects to the subsea flowline 12 some distance away from the vessel. The interface is located in a static portion of the pipeline i.e. a section which does not lift on and off the seabed as a result of vessel motions. A riser termination manifold is installed at the interface, Figure 4. The manifold consists of a forged steel block 13 that is machined with a central horizontal bore. Each end of the forging is machined with a studded flange face to connect the riser and flowline pipe sections respectively. The bore of the forging is machined with a profile that is designed to remotely align, capture, lock and seal the lower end of the inner pipe. The capture and locking mechanism is achieved by a series of dogs 14 that are hydraulically actuated either from the vessel or by a local ROV hot stab. A flow loop 15 is provided allowing circulation between the central pipe and annulus. This flow loop is isolated by hydraulically operated gate valves 16, operated from the platform using a control line run in the annulus.

An alternative arrangement, Figure 5, uses a packer17, run on the inner pipe. The packer is the same design as used in down hole applications. Once the inner pipe is run into the correct position, the packer is actuated forming a seal between the inner and outer pipe and locking the movement. A cross over 18 between the annulus and inner pipe is provided below the packer similar to above.

The riser system is installed by first installing the flowline section from a pipe lay vessel. The riser termination manifold is flanged onto the flowline section ensuring correct rotational orientation. The outer riser pipe is flanged onto the opposite end of the forging to the flowline and the laying of the outer pipe is continued to the production vessel. Once the correct length of outer pipe is installed, the upper bowl is fitted to the end of the last pipe section. The outer pipe is suspended from the lay vessel ramp and the inner pipe is assembled starting with the profiled thick walled section that mates and connects in the bore of the riser termination manifold. Subsequent pipe sections are added and the inner pipe is lowered into the bore of the suspended outer pipe. The process continues until the inner pipe reaches the termination manifold where it is locked and sealed. The inner pipe is pre-tensioned against the outer pipe and the hanger is landed and locked into the upper bowl. The upper flex joint and annulus piping is assembled prior to hand over and connection to the vessel. The vessel pipe work and control lines are connected allowing the manifold valves to be functioned and the riser flow paths circulated and pressure tested.

The subsea flowline may have a different design and thermal insulation configuration and be installed by a separate installation activity. In which case the connection between the CCR and flowline termination manifold can be achieved either subsea or at the surface by recovery of the flowline and manifold to the CCR lay vessel.

Claims

1. A pipe in pipe catenary riser system largely as described comprising a pipe in pipe bundle where the annulus may be filled with a variety of liquids and gases depending on service and operation.

2. A pipe in pipe catenary riser system largely as described in which thermal insulation is provided by air or gas filling or vacuuming the annulus.

3. A pipe in pipe catenary riser system largely as described in which the annulus is used to pump hot gas or liquid with the objective of transferring heat in to the production fluids.

4. A pipe in pipe catenary riser system largely as described in which the annulus is used as a method of providing riser base gas lift.

5. A pipe in pipe catenary riser system largely as described in which the annulus is used as a flow path for water or gas injection services.

6. A pipe in pipe catenary riser system largely as described in which a riser termination manifold is used to provide circulation between the central pipe and annulus or any other pipe in the bundle.

7. A pipe in pipe catenary riser system largely as described in which the inner pipe or pipes are installed by sliding them inside a preinstalled outer pipe.

8. A pipe in pipe catenary riser system largely as described in which the inner pipe or pipes are terminated at a subsea structure providing sealing and/or axially locking of one pipe with respect to the other.

9. A pipe in pipe catenary riser system largely as described in which the weight of the outer pipe is hung off the inner pipe via a mechanical or welded connection located near the top of the riser.

10. A pipe in pipe catenary riser system as claimed in any 1 to 9 in which the annulus is flooded during storm conditions with the objective of increasing the weight of the riser and improving its response.

11. A pipe in pipe catenary riser system largely as described in claims 1 to 9 where external buoyancy is used to form a more compliant shape containing an arch or wave.

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Application No:	GB 9914868.6	**Examiner:**	David Hotchkiss
Claims searched:	-	**Date of search:**	28 January 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): E1F (FAC1)

Int Cl (Ed.7): E21B

Other: Online: WPI, EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB2330157A	(Bluewater Terminal Systems N.V.) Whole document	Claim 1 at least
X	GB2280460A	(Altra Consultants Limited) Whole document	Claim 1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.